Michigan State research sheds new light on health dangers of nanoparticles

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The nose, usually the first line of defense against inhaled airborne particles that could damage the lungs, may itself be susceptible to the dangers of extremely small particles, called nanoparticles, which are less than 100 nanometers in size. One nanometer is one-billionth of a meter.

According to research presented by Michigan State University researchers at seminar at the annual American Association for the Advancement of Science conference titled "Nanotechnology 2006: Toxicology of Nanoparticles," combustion-derived nanoparticles, or CDNPs, have the ability to collect in the nasal airways, potentially causing a number of ailments, including rhinitis, inflammation of the mucous membranes.

CDNPs are byproducts of coal-fired power plants, waste incinerators and diesel-powered vehicles. They are also found in the production of carbon black, an elemental carbon that is widely used in rubber tires, gaskets, and in pigments for paints, plastics and inks.

"This is concerning because carbon black can be found practically anywhere," said Jack Harkema, a University Distinguished Professor of pathobiology and diagnostic investigation at MSU, who conducted the research with colleagues from the University of Rochester. "It's found in ink jet printers, car tires, pretty much anything that is black. However, our primary concern is the potential adverse health effects to people who manufacture large amounts of these CDNPs and are daily exposed to these nanoparticles."

Most of the toxicology studies of inhaled nanoparticles have focused on its harmful effects on the lung. However, nasal toxicity of nanoparticles has not been previously examined.

"This study was the first to show that inhaled nanoparticless of any sort can cause nasal pathology such as rhinitis, epithelial cell injury, and remodeling of the nasal mucous membranes that may compromise its function for smell and for defending the lung from harmful airborne agents," Harkema said.

In the laboratory, carbon black NPs are often used as surrogates for other CDNPs, like those found in diesel exhaust, to identify which physical or chemical features of extremely small particles are most responsible for their toxic effects to cells and tissues in the nose and lungs. This knowledge is important for setting occupational and environmental exposure limits to maintain air quality and protect human health.

The fact that the nasal passages could be susceptible to the dangers of such nanoparticles is alarming because the nose, in addition to its smelling duties, serves to not only humidify and warm inhaled air, but also filter it.

"It basically acts as a scrubbing tower, removing inhaled gases, vapors and small airborne particles – including nanoparticles – that may be harmful to the lung," he said. "It turns out, nasal airways may also be targets of toxicity caused by inhaled nanoparticles."

To look into the potential toxicity of these carbon black nanoparticles, Harkema and colleagues exposed laboratory rodents to high levels of the material. They found that rats developed a number of lesions on the surface epithelium, or the lining, of the nasal airways, as well as rhinitis, an inflammation of the mucous membranes of the nasal airways. They

also found that the smaller the size of the NPs the more severe the toxic injury to the noses of these exposed rats.

Mice had similar but less severe rhinitis and epithelial lesions, while hamsters did not develop rhinitis at all and only minimal alterations to the nasal epithelium. Why one rodent species is more susceptible to nasal injury than another is not yet known.

Although the effects of inhaled nanoparticles on humans have yet to be determined, "these initial findings in laboratory rodents suggest that our nose, like our lungs, is a potential target organ for toxicity of inhaled NPs," Harkema said.

Source: Michigan State University